cephalopoda of the north-eastern coast of America, by A. E. Verrill.—Notices of recent American earthquakes, by C. J. Rockwood, jun.—Observations on the height of land and sea-breezes, taken at Coney Island, by O. T. Sherman.—New method of spectrum observation, by J. N. Lockyer.—Presentation of sonorous vibrations by means of a revolving lantern, by H. Carmichael.—Chemical composition of childrenite, by J. L. Penfield.—Observations on the planet Lilæa, by C. H. F. Peters.—Efficiency of Edison's electric light, by H. A. Rowland and G. F. Barker.

Annalen der Physik und Chemie, No. 3.—On the behaviour of carbonic acid in relation to pressure, volume, and temperature, by R. Clausius.—On a relation between pressure, temperature, and density of saturated vapours of water and some other liquids (continued), by A. Winkelmann.—Researches on the vibrations of a normal tuning-fork, by R. Koenig.—Researches on the equipotential distribution of the magnetic fluids of cylindrical steel bars, by W. Schaper.—General theory of the deadening influence of a multiplier on a magnet (continued), by K. Schering.—On ultra-violet rays, by J. L. Schönn.—On a spectrotelescope, by P. Glan.—On a new simple mode of streak observation, by V. Dvorak.—Contribution to a history of the mechanical theory of heat, by E. Oedler.

Journal de Physique, April.—On the measurement of wave-lengths of infra-red radiations, by M. Mouton.—Solar spots and protuberances observed with a spectroscope having great dispersion, by M. Thollon.—Measurement of the electromotive force of contact of metals by the Peltier phenomenon, by M. Pellat.—Description and use of the telescope and scale of Edelmann, by M. Terquem.

Journal of the Franklin Institute, April.—Naval architecture, by Mr. Haswell.—Saws, by Dr. Grimshaw.—Engraving, by Mr. Sartain.—On D'Auria's engine-governor and the action of governors in general, by Prof. D'Auria.—A new hypothesis regarding comets and temporary stars, by Prof. Tobin.

Rivista Scientifico-Industriale, No. 6, March 31.—On a case of permanent polarity of steel opposite to that of the magnetising helix which produces it, by Prof. Righi.—Reflexions on an experimental and fundamental principle in hydrostatics, by Prof. Cantoni.—On Elban topaz, by S. Corsi.

No. 7, April 15.—Radiant matter and the theory of Crookes, by S. Piazzoli.—Pliocene fossils of the yellow sand found in the neighbourhood of Vigne, Schifanoia, and Montoro (Narni), with a suggestion as to the subapennine formation of these three places, by S. Terrenzi.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti, vol. xiii. fasc. iii.—On Garovaglineæ, a new tribe of Collemaceæ, by S. Trevisan.—Comparison of the winter 1879-80 with the preceding one in Milan, by Prof. Hajech.—Diurnal oscillations of the declination-needle, in 1879, at the Brera Observatory, Milan, by Prof. Schiaparelli.—Transfusion of blood into the peritoneum in an oligocitemic lunatic; effects on the circulation of blood and on the general state of the patient, by Profs. Golgi and Raggi.—The nephodoscope, an instrument for determining the direction of motion of clouds, by Prof. Fomiori.

SOCIETIES AND ACADEMIES

London

Royal Society, April 22.—"On the Critical State of Gases." By William Ramsay, Ph.D., Professor of Chemistry in University College, Bristol.

It is well known that at temperatures above that which produces what is termed by Dr. Andrews the "critical point" of a liquid, the substance is supposed to exist in a peculiar condition, and Dr. Andrews purposely abstained from speculating on the nature of the matter, whether it be liquid or gaseous, or in an intermediate condition, to which no name has been given. As my observations bear directly on this point, it may be advisable first to describe the experiments I have made, and then to draw the deductions which appear to follow from them.

A piece of barometer tubing about three inches long was sealed at one end and drawn into a capillary tube at the other; after being filled with methyl formate it was exhausted, and after two-thirds of the ether had evaporated was sealed. By this means all air was removed from the tube, which contained merely the ether and its vapour.

1. On applying heat the temperature gradually rose to 221°·5 (corr.); during the rise the meniscus of the liquid gradually became less curved, and at the above-mentioned temperature disappeared. On cooling to 218° a mist was seen at the point where the meniscus had disappeared, and the meniscus shortly afterwards became again visible.

2. Two similar tubes were prepared, one containing less and the other more of the same ether; the point at which the meniscus disappeared in the former was 228°, and in the latter 215°.

3. A tube of the shape shown was filled to the mark with methyl formate and heated in an inclined position, the portion containing the liquid being the lower. The liquid, as usual, expanded, and at the moment when the meniscus disappeared it nearly filled the lower half. The source of heat was then withdrawn, and on cooling the liquid all condensed in the *lower* half.

4. The last experiment was varied by tilting the tube after the meniscus of the liquid had disappeared, so that that half which had contained the liquid was uppermost. On cooling, the liquid condensed in the *upper* half of the tube.

5. The experiment was again varied by keeping the tube at a temperature a few degrees above the point where the meniscus vanished, for half an hour. On cooling, an almost equal quantity had condensed in each division of the tube. (During Experiments 3, 4, and 5, great care must be taken to keep the heater from draughts of cold air, otherwise unequal cooling results and distillation takes place.)

6. It was noticed that that half of the tube containing liquid, after the meniscus had vanished, appeared *full*, while the other half of the tube seemed to be *empty*. The refractive indices of the fluid contained in the tubes were therefore different. The portion of the tube containing liquid was shown to be a more powerful cylindrical lens than the empty portion, for on focussing a spot behind the tube with a microscope, the focus was shorter when the portion which had contained liquid was placed between the microscope and the spot than when the portion appearing empty was interposed.

7. From experiments on the expansion of liquids above their boiling-points, of which numerical details shall be given on a future occasion, it appears probable that the specific gravity of the hot liquid, at the temperature at which the meniscus vanishes, is identical with that of the compressed gas evolved from the liquid. This has also been noticed by Ansdell in two cases, viz., hydrogen chloride and acetylene.

8. From observations on the expansions of liquids at high temperatures it has been proved that liquids above the temperatures at which their menisci vanish are not uniformly compressible.

From these observations I would draw the following inferences:—When a liquid is heated under pressure it expands, and at the same time evolves vapour. The vapour gains in specific gravity, while the specific gravity of the liquid is rapidly diminishing. *The critical point is that point at which the liquid, owing to expansion, and the gas, owing to compression, acquire the same specific gravity, and consequently mix with one another.* From the first experiment it is seen that, on cooling, the liquid contracts more rapidly than the gas, and consequently separates as a mist through the whole of the tube, and, from its gravity, separates at the lower half. The second experiment shows that when the tube contains a small amount of liquid the space left for gas is larger, and consequently more vapour must be given off by the liquid before enough gas can be compressed till it acquires the same specific gravity as the liquid; the temperature at which the meniscus disappears is consequently higher. If the space left for gas be smaller, the opposite is the case. The fourth, fifth, sixth, and seventh experiments demonstrate that by suitable means it is possible to prevent, or rather to retard, the mixing of gas and liquid. They then retain their several refractive indices. If, however, time be allowed for diffusion through the capillary tube, the whole becomes homogeneous, and the refractive indices of the fluids contained in either portion of the tube are then identical.

So long as gas is being compressed, pressure rises gradually with decrease of volume, whereas, even above their critical points, liquids are comparatively incompressible.

In conclusion, let me refer to a paper communicated to the Society by Messrs. Hannay and Hogarth last October, entitled "On the Solubility of Solids in Gases." Should the views of the subject suggested by the above experiments be correct, it follows that these gentlemen have observed nothing unusual, but

merely the ordinary phenomenon of solubility of a solid in a hot liquid. This view is borne out by their own experiments. They found that on reducing pressure, that is, on allowing the liquid to change to gas, the solid precipitated; and also on heating the tube containing the solution locally, that is, by converting the liquid near the heated point into gas, precipitation took place. I have taken the liberty of repeating one of their experiments with a slight modification.

A tube shaped like that used in Experiment 3, after a small fragment of potassium iodide had been placed in the lower compartment, was filled with nearly anhydrous alcohol; and after rather more than two-thirds of the alcohol had been evaporated under reduced pressure, the tube was sealed. The lower portion of the tube contained a strong alcoholic solution of potassium iodide, besides a small piece of undissolved salt. The upper portion of the tube was free from alcohol, but its walls were incrusted with a thin crystalline film of potassium iodide. The tube was heated in a sloping position, the liquid being in the lower half. After the meniscus had disappeared, the iodide in the lower half of the tube dissolved, while the film in the upper half, even in its thinnest portions, remained unchanged. On cooling, very sparkling crystals deposited in the lower half of the tube, but no glittering crystals in the upper half.

By repeated distillation the iodide in the upper portion of the tube was washed down into the lower half, and when dry the sides of the upper tube were quite bright and clean. The tube was again heated in the same position to 20° above the temperature at which the meniscus had disappeared. On cooling, the sparkling crystals again appeared in the lower tube, but not a trace in the upper tube. To eliminate all possibility of mistake the experiment was repeated five times with the same result, and finally the alcohol was distilled into the upper tube; it was then broken off, and its contents carefully tested for iodine with sodium hypochlorite and starch-paste. There was not the faintest blue colour, and it is therefore certain that potassium iodide is absolutely insoluble in alcohol vapour.

Messrs. Hannay and Hogarth also found that the absorption spectrum of coloured salts remains unaltered, even when the liquid in which they are dissolved loses its meniscus. Surely no clearer proof is needed to show that the solids are not present as gases, but are simply solutions in a liquid medium.

To eliminate any source of error dependent on the use of methyl formate, two other substances were employed, viz., carbon disulphide, CS_2, and carbon tetrachloride, CCl_4. The former of these liquids was rectified five times over sodium, and then boiled at 48·7 (corr.). The latter was rectified four times over phosphoric anhydride, and boiled constantly at 77·5 (corr.).

They yielded the following results:—

	Tube more than half full.	Tube less than half full.
CS_2	282·7	286·4
CCl_4	283·3	288·4

These readings are given for the first appearance of a cloud in the tube on cooling, and differ from the temperature at which the meniscus disappears by being about half a degree lower. They also do not represent extreme instances, for in the first cases the liquids do not entirely fill the tube, and in the second about half an inch of liquids remains in the tubes before it becomes impossible to distinguish liquid from gas.

The experiments described in a former part of this paper, relating to the difference of refraction shown by a liquid above its so-called critical point, and the gas evolved from it, were repeated with carbon tetrachloride and carbon disulphide, and held good in both cases. The phenomena observed differed in no particular from those already described.

In conclusion, a few remarks on the liquefaction of the so-called permanent gases may not be deemed out of place. If the deductions from the above experiments be correct, it follows that that form of matter which we call gas may be converted into liquid by pressure alone; but the meniscus will never become visible, for the process of change is a gradual one. To render the meniscus visible it is necessary to take advantage of the fact that liquids under such circumstances have a much greater coefficient of expansion by heat, and conversely, a much greater coefficient of contraction on withdrawal of heat, than gases. It therefore becomes necessary to lower the temperature until the liquid by contraction acquires a specific gravity greater than that of its gas, and then, and not till then, does the phenomenon of a meniscus become observable.

April 29.—"On the Diurnal Variation in the Amount of Carbon Dioxide in the Air." By George Frederick Armstrong, M.A., F.G.S., C E., Professor of Engineering in the Yorkshire College, Leeds. Communicated by Prof. Thorpe, F.R.S.

Summarising the results contained in this communication, it may be stated—

1. That the normal amount of carbonic acid present in the air of the land is distinctly less than that usually stated, and that it does not exceed 3·5 vols. in 10,000 of air.

2. That plants absorb carbonic acid during the day and exhale it at night, and that vegetation therefore affects the quantity of carbonic acid present in the air, decreasing it by day and increasing it at night.

3. That from this cause there is, during that part of the year when vegetation is active, at least 10 per cent. more carbonic acid present in the air of the open country at night than during the day.

Chemical Society, May 6.—H. E. Roscoe, president, in the chair.—The following papers were read:—On the action of sodium on phenylic acetate, by W. H. Perkin, jun., and W. Hodgkinson. Hydrogen, acetic ether, phenol, acetic acid, salicylic acid, a white crystalline substance melting at 48° C., having the composition $C_{15}H_{12}O_3$, and a yellow crystalline substance melting at 138°, having the composition $C_{18}H_{14}O_4$, were obtained; by heating cresylic acetate and sodium, acetic ether and salicylic acid were formed.—Preliminary notice on the action of sodium on some ethereal salts of phenylacetic acid, by Dr. Hodgkinson. The first products of this action are the corresponding ethylic, &c., ethers of phenylacetic acid. The phenyl group being replaced by hydrogen, it reacts with sodium on another portion of the original ethereal salt, forming various liquid and solid bodies, which the author has investigated, but whose constitution is as yet undetermined.—On the determination of nitrogen in carbon compounds, by C. E. Groves. The author described and exhibited an improved and simple apparatus for facilitating the collection and measurement of the nitrogen evolved during the combustion of a substance according to Dumas' method.—On essential oil of sage, by M. M. P. Muir. The composition of this oil varies with its age, salviol and camphor being formed as it gets older. English sage-oil contains cedrene. The terpene of sage-oil is identical with that of French turpentine. The author has examined the action of oxidising agents, phosphorous pentachloride, and bromine.—On the presence of nitrogen in iron and steel, by A. H. Allen. By passing steam over iron at a red-heat, and also by dissolving iron in hydrochloric acid, the author has satisfactorily proved that ammonia is formed equal to 0·0041 to 0·0172 parts of nitrogen per hundred parts of iron and steel.—On the mode of application of Pettenkofer's process for the determination of carbonic acid in expired air, by Dr. W. Marcet. The author describes and figures a portable apparatus which he has successfully used in upwards of 350 determinations of carbonic acid made during some investigations on the effect of altitude on the phenomena of respiration.—On an improved form of oven for heating sealed tubes and avoiding risks of explosions, by Watson Smith.—Note on a convenient form of lead-bath for Victor Meyer's apparatus for determining the vapour-densities of high boiling substances, by Watson Smith.

Anthropological Institute, April 27.—Major-General A. Pitt-Rivers, F.R.S., vice-president, in the chair.—Edward Tyrrell Leith, LL.M., was elected a new member.—A paper entitled "Further Notes on the Romano-British Cemetery at Seaford, Sussex," by Mr. F. G. Hilton Price and Mr. John E. Price was read. It was a continuation of one read before the Institute by the same authors in November, 1876. During the summer of 1879 these gentlemen again visited Seaford, and made further excavations in the Roman Cemetery upon the Downs, in which they discovered several urns, a drinking cup of Durobrivian pottery, Samian pateræ, flint celts of the neolithic type, and many flint flakes. In one particular interment a large urn full of charred human bones was discovered, having a Samian cup in its mouth for the purpose of keeping out the earth, another cup of elegant form of Durobrivian ware was found on its left side, and a food vessel and patera of Upchurch pottery on the right side. In close proximity to this interment was a similar one; the urn was much crushed, but beneath a patera of Samian ware a coin of Faustina Junior, the daughter of Antoninus Pius and wife of Marcus Aurelius, was found. This was most important as giving an approximate date to the interments; they could not be earlier than between A.D. 161-180. In another

part of the Downs, in a place called the Little Burys, black patches were of frequent occurrence in the sand, which were composed of charcoal, fragments of burnt bone, a flint flake or two, and frequently iron nails. In one particular spot a batch of over ninety iron studs was found, mixed up with bone ashes and charcoal. The authors considered that the patches of charcoal without an urn indicated pauper burials, or the burials of soldiers, as this place was a military station. The pottery and other relics discovered were exhibited.—General A. Pitt-Rivers exhibited a series of plans and relics from Mount Caburn.

Photographic Society, April 6.—J. Glaisher, F.R.S., president, in the chair.—Mr. J. H. Dallmeyer, F.R.A.S., read a paper on principles of optics involved in lantern construction; and on a new enlarging lens especially designed for use with the magic lantern, in which he described all previous existing objective lenses and condensers and the scientific principles which ought to be observed in their construction, and then exhibited and described a new condenser he had constructed containing the essentials required, viz., quantity and quality of light; also a new objective lens which gave equal definition at the margin as well as at the centre of the picture, freedom from distortion, and perfect achromatism.—A paper was read by Capt. Abney, R.E., F.R.S., on the use of silver iodide in a gelatino-bromide emulsion, showing that the introduction of iodide into the ordinary gelatino-bromide emulsion did not decrease its sensitiveness, as also that it permitted the use of an ordinary yellow light to work in—same as for wet collodion.—Also a paper, by W. England, on a drying box for gelatine plates.

GÖTTINGEN

Royal Society of Sciences, January 10 (continued).—On boracite, by Herr Klein.

February 7.—The affinity-grouping of old German dialects, by Herr Bezzenberger.—On physiological retrogression of ovarian eggs in mammals, by Dr. Brunn.—On sexual propagation of *Dasycladus clavæformis*, Ag., by Herr Berthold.—The theory of numerical-theoretical functions, by Prof. Cantor.—On a class of functions of several variables which arise by inversion of the integrals of solution of linear-differential equations with rational coefficients, by Herr Fuchs.

March 6.—On the theory of partial linear differential equations, by Dr. Krankenhagen.

VIENNA

Imperial Academy of Sciences, January 22.—The following papers, &c., were read:—The Diptera of the Imperial Museum in Vienna, by Prof. Brauer.—On projectivities and involutions in plane rational curves of the third order, by Prof. Weyr.—The periods of springs, by Herr Klönne.—On the behaviour of phenanthrenchinon towards ammonia, by Prof. Sommaruga.—On chlorhydrate of morphin, by Herr Tausch.—The more recent deposits on the Hellespont, by Prof. Neumayr and Herr Calvert.—Survey of the geological relations of a part of the Ægean coast lands, by Prof. Neumayr, Dr. Bittner, and Fr. Teller.

February 5.—Communications from the Embryological Institute of Vienna University, by Prof. Schenk.—The respiratory apertures of the Marchantiaceæ, by Prof. Leitgeb.—On nectar-secreting trichomes of some species of *Melampyrum*, by Prof. Rathay.—On the yearly period of the insect-fauna of Austria-Hungary. V. Rhynchota, by Herr Fritsch.—Electric action on the form of flames, by Herr Goldstein.—On the probable errors and the available results of calculation deduced from imperfect numbers, by Dr. Rotter.—Tables of observations at the Central Institution for Meteorology and Magnetism.

PARIS

Academy of Sciences, May 3.—M. Edm. Becquerel in the chair.—The following papers were read:—On the transcendants which play a fundamental part in the theory of planetary perturbations, by M. Tisserand.—On the gases retained by occlusion in aluminium and magnesium, by M. Dumas. While silver imprisons oxygen, aluminium and magnesium specially retain hydrogen. The substances were heated to a high temperature *in vacuo*. The 89·5 c.c. gas given off by 200 gr. aluminium (representing 80 c.c.) at 17° and 755 mm., contained 1·5 c.c. CO_2 and 88·0 c.c. H.; 20 gr. magnesium gave 12·3 c.c. H. and 4·1 c.c. CO. (In another case there was both CO and CO_2.) The whole of the magnesium was volatilised and condensed in stalactites (in great purity) about the neck of the retort.—On the cholera of fowls; study of the conditions of non-recurrence of the malady, and of some others of its characters, by M. Pasteur. The extract of a filtered culture-liquid of the microbe, when injected, produces sleep (for a time); the microbe seems to generate a narcotic during its life. This effect is independent of disorders produced by multiplication of the parasite in a fowl's body. The malady sometimes occurs in a chronic form.—On extension of the theory of germs to the etiology of some known maladies, by M. Pasteur. He shows reasons for attributing boils, osteomyelitis, and puerperal fever to the development of minute organisms.—On a letter of Admiral Cloué relative to waterspouts, by M. Faye.—Formation of leaves and appearance of their first vessels in Iris, Allium, Funkia, Hemerocallis, &c., by M. Trécul.—On the law of reciprocity in the theory of numbers, by Prof. Sylvester.—Experimental researches on the decomposition of some explosives in a closed vessel; composition of the gases formed, by MM. Sarran and Vieille. The products are indicated in the case (1) of pure gun-cotton (this gives, per kgm. of substance, 741 litres of gas made up of 234 CO, 234 CO_2, 166 H, and 107 N), (2) of a mixture in equal parts of gun-cotton and nitrate of potash, (3) of a mixture of 40 parts gun-cotton and 60 nitrate of ammonia, (4) of nitroglycerine, (5) of ordinary blasting-powder.—Cometary paraboloids, by Mr. Chase.—On simultaneous linear equations, and on a class of non-plane curves, by M. Picard.—On Gauss's formula of quadrature, by M. Callandreau.—Theorem on cubic and biquadratic equations, by M. Desboves.—General equation giving the relation which exists for all liquids between their temperature and the maximum tension of their vapours at this temperature, by M. Pictet.—*Résumé* of the laws which rule matter in the spheroidal state, by M. Boutigny. The fifth law, that of repulsive force at a sensible distance, is represented as the most important, because antagonistic to universal attraction. Non-volatile bodies (as pieces of wax, tallow, stearic or margaric acid, &c.), are suspended in a heated capsule, *without vapour or gas* arising from their decomposition. Water dropped, *e.g.*, from the top of the Pantheon, 70 m. high, on a heated capsule at the bottom, is repelled instantaneously by the repulsive force generated by the heat in the capsule.—Dissociation of the hydrate of butyl-chloral, by MM. Engel and Moitessier. They find here a new confirmation of the law they formulated; the dissociation of a body whose two components are volatile does not take place in presence of the vapour of one of the components at a tension above that of dissociation of the compound.—On the determination of glycerine in wines, by M. Raynaud.—On legumine, by M. Bleunard.—On gelose, by M. Porambaru.—Variations of temperature with the altitude for the great colds of December, 1879, in the valley of the Seine, by M. Lemoine. The data agree with those lately given by M. Alluard.—On the variability of teats in the ovides of the Lower Cevennes, by M. Tayon.—On the structure of some Corallidæ, by M. Merejkowsky.—On the analogies which seem to exist between cholera of fowls and nelavan, or the malady of sleep, by M. Déclot.

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